Performance Evaluation of a Pilot Scale Land-Based Salmon Farm

Ministry of Agriculture, Food and Fisheries
Province of British Columbia

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Introduction

The BC Ministry of Agriculture, Food and Fisheries (MAFF) issued a Request For Proposals (RFP) for closed-containment and alternative 'green' salmon farming technologies during the summer of 2000. At that time a moratorium on new salmon farm tenures had been in place for several years. New salmon farm tenures were used as an incentive to attract interest and investment in these new, untested, technologies. Proponents were expected to operate conventional (open-mesh) technologies adjacent to the experimental technologies.

Agri*Marine's* proposal to renew operations at a pre-existing land-based salmon farm in Cedar was successful. The facility had been built for the production of farmed salmon by Hagensborg Resources in the 1980's but had closed mid-way through its first production cycle. In the intervening years, a shellfish producer had bought the facility.

The site consists of eight 18-foot deep concrete tanks; each tank holds 750 m3 (750,000 litres) of seawater. Seawater is pumped into the tanks from the adjacent Stuart Channel. The bottoms of the tanks are all located above the high tide mark meaning that the seawater pumps are constantly pumping water at a positive head.

Agri*Marine* agreed to rent four of the facility's circular tanks from the current owner. Atlantic salmon, Chinook and Coho smolts were ponded at different times during the spring of 2001. Harvesting started in the spring of 2002. The fish were marketed as 'eco-salmon', an environmentally friendly product, through an exclusive agreement with a regional supermarket.

For this project, a comparative economic and environmental analysis of the land-based production system and a conventional production system was not done as the paired marine tenure has yet to be developed.

Results

The average Cost of Production (COP) at the Cedar farm across all three species (Coho, Chinook and Atlantic salmon) was $5.02[1] per pound (round weight[2]). Production costs for Chinook were $10.90 per pound (round) and for Coho were $3.22 per pound (round). A summary of the key biological data and economic costs is presented in Table 1. Detailed financial accounts from the Cedar farm are attached in Appendix 1.

[1] All prices are in Canadian dollars.
[2] Round weight refers to the whole, unprocessed, weight of the fish.

Table 1. Key Production Data.

Species:	Chinook	Coho
Total number of smolts:	21,000	25,220
Ponding weight (grams):	142	18
Total pieces at harvest:	7,400	21,792
Total pounds (dressed, head on) at harvest:	25,513	102,760
Average harvest weight (dressed, head-on, lbs):	3.45	4.72
COP (per pound):	$12.81	$3.70
Rearing months:	May/01 → June./02	June/01 → Aug./02
Percent survival:	less than 35 %	87%
Total feed fed (kg):	17,095	65,038
Feed Conversion Ratio:	N/A	1.2
Peak density (kg/m3):	N/A	42

Major Cost Factors

Farm labor	$189,239
Feed	$166,179
Oxygen	$47,765
Hydro	$56,839
Farm rental	$97,880
R&D	$55,852
Head office	$82,592
Sum	$696,346

The data above do not include smolt costs.

Discussion.

Environmental Performance

The environmental attributes of land-based salmon farming attract a lot of interest. Many people view it as helping to reduce the environmental footprint of salmon farming. The environmental issues that surround salmon farming, as identified by the Environmental Assessment Office's Salmon Aquaculture Review (1997), include farm siting, genetic and fish health interactions between farmed and wild stocks, interactions with marine mammals and the impacts of waste products.

The absence of a marine tenure for the project at this time means that there is no comparative facility against which to measure environmental performance. However, given that the farmed stock is held on land and in cement tanks, it can be said that the likelihood of genetic interactions between the farmed stock and wild stocks is virtually non-existent. Similarly, the likelihood of interactions with marine mammals is also considerably lower, if not eliminated.

Land-based technologies can also be designed and built to collect waste products and to treat effluent waters. Agir*Marine* proposed to install a drum filter for waste collection at the Cedar site and recover and send the solid wastes to a composting facility. The filter has not been installed due to logistical issues resulting from the initial design of the outflow pipes. As a result, the effluent from the facility is discharged untreated to a single point source at depth in the Stuart Channel.

Biological Performance

Typical survival rates for netpen Chinook and Atlantic salmon are in the mid to high 80's and low 90's. The performance of the Cedar Chinook throughout the grow-out trial was greatly impacted by early mortality (roughly 66%) during

transport to the facility. The survivors suffered chronic Bacterial Kidney Disease mortality through the rest of the rearing cycle. The data from the Cedar Chinook program do not represent what can be achieved by land-based production and were not further considered in this analysis. Similarly, the Cedar Atlantic salmon program was terminated early due to poor stock performance and is not discussed any further. The remainder of this evaluation is based upon data for the Coho only.

The performance of the Coho in the tanks was comparable to expectations for Atlantic salmon in marine open-mesh cages. Atlantic salmon generally reach ten to twelve pounds about 15 months after saltwater entry. The Cedar Coho were growing at a comparable rate. Survival to harvest (87%) was good and comparable with industry standards for Coho. Mortalities were somewhat inflated due to the difficulties of working and (particularly) harvesting in and around concrete tanks. Feed conversion rates of 1.2 are also very good. The peak densities achieved at the facility (42kg/m3) greatly exceeded typical maximum netpen densities of 20kg/m3, the period of peak densities corresponded with the highest demand for supplemental oxygen.

Table 2 presents the measured water quality data at the Cedar farm.

Economic Performance

The COP for the Cedar farm was higher than for farmed Coho from marine netpens. According to Agri*Marine*, the "price received for the (Cedar) fish (Coho) was $3.25 per pound, dressed head on and gill out. This price did not include the cost of boxes or transportation from the processor in Nanaimo to the distributor in Victoria. Those costs are estimated to be another $ 0.15 per dressed pound, putting the FOB distributor price at $3.40. (Commodity) market prices for other farmed Coho in 2002 were around $2.25 per dressed pound". The additional cost of the Cedar Coho would either be absorbed by the producer and/or retailer or passed on to the consumer.

Table 2.

2001	Temp.(◦c)	D.O(ppm).	Salinity(ppt)	Turbidity(m)
May	10.6	7.7	31.2	6
Jun	10.7	6.6	31.1	5.1
Jul	12.1	6.2	30.8	4.9
Aug	12.5	6.5	30.9	5
Sep	12.5	7.2	30.6	5
Oct	11.3	8	30.8	5
Nov	10	7.7	30.7	5
Dec	8.6	8.7	30.1	5
2002				
Jan	8.1	8.2	29.9	8
Feb	7.6	8.3	30	5
Mar	7.6	8.2	30	5
Apr	8.5	8	30	4.9
May	9.6	7.6	30.3	4.9
Jun	10.5	8.3	30.5	5
Jul	11.7	8.1	30.9	5
Aug	12.5	7.7	30	5

It should be noted here that there is an array of production scenarios for this facility. Agri*Marine's* venture is operating in only four of eight tanks at Cedar. The project has also accrued substantial costs resulting from the experimental nature of the project.

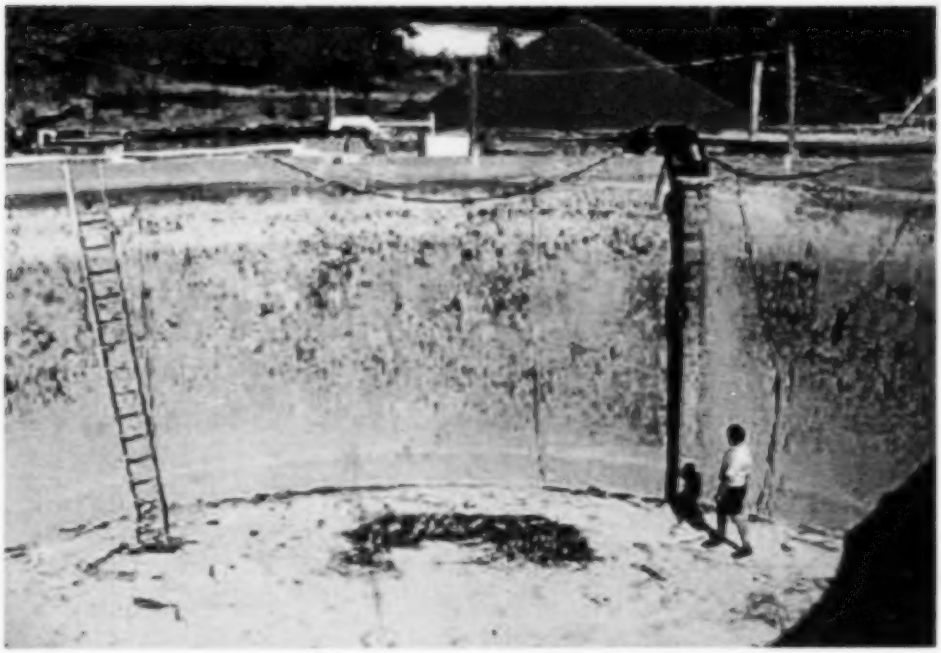
Notably, the Cedar COP significantly undervalues the costs of land-based production for new facilities. The rental cost to Agri*Marine* for the four tanks was $97,880. The original cost of the facility was one half million for the land and an additional $7 million for construction. In 1997 the Salmon Aquaculture Review

estimated that the capital costs for a 1000 tonne land-based facility were in the order of $21 to $27 million with full water re-use systems. Standard accounting practices would depreciate the facility over a period of several years. A twenty year depreciation period, for example, would result in an annual cost to the producer of $1 to $2 million or 10 to 20 times the rental fee. This additional cost would then have to be applied to the product.

Sales Price

Agri*Marine* has an exclusive sales arrangement with a Vancouver Island supermarket chain called Thrifty Foods (Thrifty's). Thrifty's built a multi-media marketing campaign including print, radio and television and introduced the product as 'eco-salmon', an environmentally friendly product. The introductory price for Chinook from the Cedar farm was $2.98/pound dressed head on and extending up to $5.98/pound for skin on pin-boned fillets (week of June 12-18, 2002). Product that was not sold fresh was frozen to provide a year-round supply and has since sold out.

Both Thrifty's and Agri*Marine* incurred losses during this first cycle at the Cedar farm. Thrifty's reports that 20% of the 'eco-salmon' customer base does not buy netpen produced farmed salmon because of environmental concerns. Thrifty's experience with other products forms has been that consumers will pay as much as a 20% premium for products that are consistent with their value systems and expect that the market for 'eco-salmon' will be similar.



Conclusions

The biological performance of the Coho was comparable to that of netpen raised Coho. In some areas, densities for example, production parameters at Cedar exceeded levels that are characteristic of open mesh netpens. This indicates that the technology itself does not constrain fish performance.

Incremental, though not insignificant, improvements in economic performance can be made through economies of scale, reduced oxygen costs and improved husbandry techniques. Inventory accuracy and operating the tanks at full capacity are also keys for maximizing economic performance. Incremental gains can also be reached through marketing processes as certain consumer groups are likely to pay a premium price for farmed salmon produced in land-based facilities. However, given the estimated capital expenditure needed for a new facility, it is not likely that a new land-based facility could be economically viable.

There may be some unique locations and/or existing facilities, such as at Cedar, where entrepreneurs can explore the viability of land-based production However, rather than viewing land-based production as a competing form of technology, it is more likely that land-based farming will find a role as a complementary form of technology that increases the range of products available to consumers.

References:

1997. Environmental Assessment Office. Salmon Aquaculture Review. http://www.eao.gov.bc.ca/